Lagrangian Floats For Deep Convection

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LONG TERM GOALS

I aim to understand the process of deep convection in the ocean.

OBJECTIVES

Near surface water is mixed to great depth at a few high latitude locations, thereby forming the deep and bottom masses of the ocean. This proposal has supported the development and deployment of neutrally buoyant floats in the Labrador Sea in the winters of 1997 and 1998 and the analysis of the resulting data. These floats provide detailed information on the processes and rates of deep convection.

APPROACH

Lagrangian Floats (see figure) accurately follow water motions through a combination of a density which matches that of seawater and a high drag. The density is matched to that of the ambient water by actively changing the float's volume and will stay matched, despite changes in pressure and temperature, though a combination of active control and a hull compressibility which is close to that of seawater. High drag is achieved through a large circular cloth drogue attached to the float. The horizontal motion of the float is determined by acoustic tracking (RAFOS) and its vertical motion is determined from pressure. Data is relayed at the end of the 2-month mission via satellite (ARGOS). These data are supplemented by meteorological and oceanographic data from other investigators involved in the Labrador Sea Deep Convection experiment.

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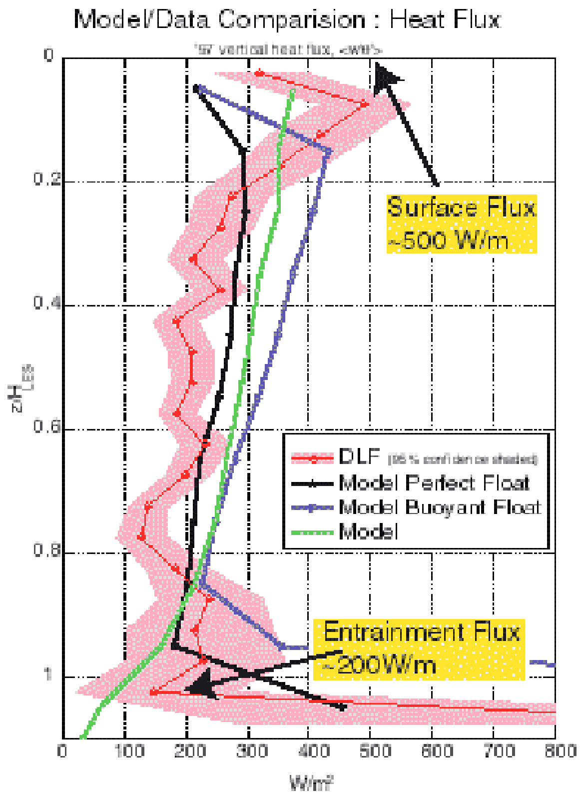
WORK COMPLETED

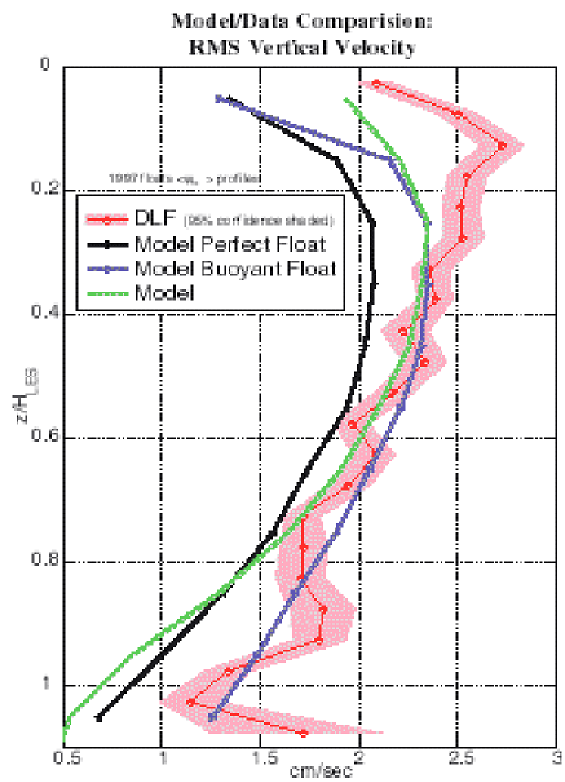
Our data from both 1997 (13 floats) and 1998 (7 floats) has been completely processed and calibrated and most of the basic data analysis completed. The first cut at a detailed comparison between the data and LES modelling of deep convection by Ramsey Harcourt (NPS, Monterey) has been completed. Much of this work was done by graduate student Elizabeth Steffen who will use this data for her Ph.D. work.

RESULTS

The two figures show comparison between the float data and the results of an LES model (Ramsey Harcourt, NPS) of deep convection in the Labrador Sea. Data from simulated Lagrangian floats, some perfect and some imperfect, is compared to the real data.

The first figure (left) compares the profile of vertical heat flux, <w'T'>. The major difference between model and data is a near surface maximum in measured heat flux which is not reproduced well by the model. The major reason for this is the low resolution of the model (50 m) which is insufficient to resolve this feature. Physically, this maximum may result from near-surface processes, such as horizontal Ekman heat flux, which are not included in the model, or from the non-Lagrangian features of the float motion.





The second figure (right) compares the rms vertical velocity from the model and data. The comparision is good in the middle of the boundary layer, particularly for the "buoyant float" simulation which most accurately represents the float dynamics. The model fails near the surface, probably again due to its low resolution.

Overall, the model does a good first order prediction of the measured properties, but clearly shows some differences with the observations. The significance of these will be investigated as the major part of E. Steffen's Ph.D. work.

IMPACT/APPLICATIONS

We expect this study to provide the first direct evaluation of models of deep convective turbulence and thus lead to improved simulations of this important process.

RELATED PROJECTS

These floats are close relatives of those used to study mixing in the Littoral zone and upper ocean mixed layer funded by ONR 322PO. Mixing processes in these various environments are similar in many ways and we learn the most by comparing and contrasting them.

PUBLICATIONS

The Lab Sea Group, 1998, The Labrador Sea Deep Convection Experiment, *Bulletin of the American Meteorological Society*, Vol. 79, No. 10, pp. 2033–2058.